An Empirical Analysis of Pharmaceutical Innovation and Technology Transfer Landscape

## Introduction

The benefits of pharmaceutical innovation in the form of dosage forms, diagnostic tools, and medical devices provided for the well-being of society are well accepted. However, with ongoing technological development and new applications in the pharmaceutical industry such as artificial intelligence, precision medicine, big data analytics, etc., the impacts of these are continuously being solicited. This in turn generated an interest in applying and adopting developed technologies, effective commercialization strategies, and gauging the socio-economic impacts. Accordingly, a need is being felt to identify the enablers and barriers to effective technology transfer and commercialization. Also, understanding the innovation ecosystem and collaboration for research done at an academic level is the need of the hour. Our study is a contextual effort towards identifying these needs in the context of pharmaceutical innovation with the help of case studies, taking due consideration of the aspects and issues of an effective academia-industry collaboration.

## Objectives

We undertook an empirical study to ***identify the factors impacting effective technology transfer by identifying the gaps influencing innovation and technology transfer among academia and industry,*** with the **first objective.** To conform to this, sub-objectives such as (i) conducting an extensive search on publicly available literature databases; (ii) preparing and circulating questionnaires to identify the awareness and understanding of the innovation and technology transfer mechanisms; and (iii) identifying the key factors influencing innovation and technology transfer in the pharmaceutical industry and studying the interdependency among the identified key factors were performed. Further, the mapping of innovation and technology transfer trends has been studied, considering case studies of COVID-19 [communicable] and arthritis [non-communicable] diseases. Also, innovation trends in the upcoming research era [precision medicine] have been studied.

The conceptual model(s) for bridging the gaps for effective collaboration and technology transfer were proposed as the second objective. Further, we undertook confirmatory statistical methods for validating the identified gaps and questions using structural equation modelling as the third objective. Finally, recommendations for fulfilling identified gaps have been provided for an effective technology transfer for pharmaceutical innovations.

**Methodology:** For quantitative analysis, empirical data had been collected by researching open-source databases and doing case studies, and then a questionnaire-based survey (Google Form) was e-mailed to get practitioners' responses. The survey's outcome was taken into consideration, and the questions were validated using statistical analysis as a qualitative approach.

**Results, Conclusion and Outcomes**

Based on the in-depth literature review, a total of 20 questions were framed, and to ensure validity, a pilot study was conducted by sending these questions via a Google Form to a selected group of 50 individuals with excellent experience in the pharmaceutical sector, particularly in research, development, and technology transfer. Very good input was received by these well-experienced professionals. The suggestion from the industry leaders was that the factors given in the questionnaire are inconclusive. Subsequently, case studies for mapping innovation and technology transfer trends were done, and three more questions were added based on the outcome.

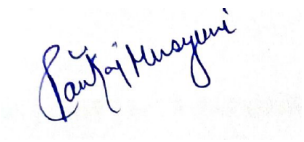
Accordingly, a total of 23 questions were circulated for measuring the opinion on the rating scale of strongly agree (5), moderately agree (4), neutral (3), moderately disagree (2), and strongly disagree (1). We have received 551 complete responses (return rate of 73.46%) out of 750. In this, 55.2% of respondents were in the academic domain, and 44.8% of respondents were in the industry domain. For designation, it has been observed that 14.3% of respondents were managers, 43.7% of respondents were professors, 11.4% of respondents were researcher scholars, and 30.5% of respondents were research scientists. These responses were analyzed statistically, and the reliability in terms of Cronbach alpha was found to be 0.933, reflecting a high level of internal consistency for the identified factors. Further, the Kaiser-Meyer-

Olkin (KMO) found 0.947, showing that the questions are valid with reference to the factors covered.

The study concluded that intellectual property challenges, GMP and GLP facilities for research and development (R&D), cost of R&D, challenging approval process for drugs, risk of failure, impractical expectations for innovation, lack of innovation strategies, resistance to change, lack of internal and external collaboration, difficulty in transitioning from one phase to the next, result of commercial output, and challenges in finding the right partners were identified as the most important factors affecting successfully transferring technology in the pharmaceutical domain.

Considering the literature review, survey analysis, and case studies, three conceptual model(s) have been proposed: (i) helping academic institutions to recognize the innovation ecosystem and technology transfer; (ii) for understanding the requirements of academia and industry; and (iii) for providing a solution for connecting gaps among academia and industry.

The proposed models are flexible, easy-to-use instruments for assessing the potential socio-economic impact of research projects at various execution stages. In summary, the present work contributes to the identification of gaps in innovation and technology transfer, the know-how of technology commercialization, and suggestive models for effective technology transfer and collaboration.



**Signature of Student**

**Signature of Supervisor**